MISR Level 2 Aerosol/Surface Products Quality Statement August 13, 2003

Quality Designator:

- **Stage 1 Validated:** AEROSOL - aerosol optical depth over heterogeneous surfaces and dark water
- **Provisional:** LAND
- **Beta:** AEROSOL - aerosol optical depth over homogeneous surfaces; aerosol Angstrom exponent

MISR maturity level definitions

This statement applies to MISR Level 2 Aerosol/Surface Products for August 15, 2003, and beyond until such a time as further improvements to MISR software are made. See the Versioning Page for an in-depth explanation of the differences between various MISR product versions. Quality statements covering earlier time periods are accessed through links at the bottom of this page.

An extensive review of product quality has not yet been performed. Please read the summary words of caution if you have not done so already.

Although there are warnings relating to Beta and Provisional quality parameters, the MISR Level 2 Aerosol/Surface software which generated these products is believed to be functioning well except where noted below. This statement highlights major known problems and issues with the products, as well as functionalities which are currently not implemented.

Aerosol | Land | Ocean

AEROSOL (a.k.a. AS_AEROSOL, MIL2ASAE) (generated by MISR PGE9 executables)

PRODUCT MATURITY

All aerosol parameters now have "Provisional" status with the exception of:

Status	Parameter
Stage 1 Validated	RegMeanSpectralOptDepth
Beta	ChisqHomog, OptDepthHomogCalcPerBand, ChisqHomogCalcPerBand, RegMeanAngstromExponent, RegStDevAngstromExponent, RegBestFitAngstromExponent
Not yet implemented	RegBestFitMixtureEqRefl, RegSfcRetrOptDepthUnc, OptDepthDWCalcPerBand, OptDepthOTACalcPerBand, ChisqAbsCalcPerBand

Product users should be aware that the aerosol models used in the retrieval analyses provide a practical means of allowing a determination of optical depth, and some preliminary validations of optical depth have been performed, as described below. However, it has not yet been verified that any particular model which successfully fits the observations should necessarily be considered an indicator of the actual aerosol type. As the MISR retrieval process matures, the constraints and thresholds used will be tightened, resulting in a decrease of the number of successful aerosol models for any particular retrieval. This process, coupled with a more rigorous comparison of MISR and ground truth data (AERONET and field campaigns) which includes aerosol particle size distribution and other microphysical properties, will determine how and to what extent the model results can be interpreted. Both activities are in progress.

AEROSOL OPTICAL DEPTH AVAILABILITY AT STAGE 1 VALIDATED QUALITY LEVEL

Aerosol optical depth is now at Stage 1 Validated maturity level. A comparison of retrieved aerosol optical depths for coincident MISR and AERONET data was performed for the years 2001-2002, and the results are reported here to provide error envelopes for the MISR aerosol optical depth retrieval uncertainty. The comparison shows that over land, the differences between MISR and AERONET retrievals are dominated by random scatter, while over water, MISR retrieved optical depths are biased higher than AERONET. This PDF document of tables shows uncertainties as a function of wavelength, and binned by optical depth magnitude, for land and water cases.

AEROSOL ANGSTROM EXPONENT AVAILABILITY AT BETA QUALITY LEVEL

Aerosol Angstrom exponent is now available at the Beta quality level. The aerosol Angstrom exponent parameters are computed using all four MISR wavelengths.

ACP DEPENDENCY
The quality of the aerosol product depends upon the quality of the Ancillary Climatology Product (ACP). The ACP contains information on component aerosol particle properties and mixtures of aerosol components assumed by the retrieval algorithm. The ACP was updated in April 2002 with a new aerosol component dataset and a new mixture dataset. Refer to the ACP quality statement for further information.

TASC DEPENDENCY
The MISR TASC (Terrestrial Atmosphere and Surface Climatology) dataset provides information on the climatological conditions of the area being observed by the MISR instrument. This information is used during the aerosol retrieval process. The TASC dataset is gridded on a month-by-month temporal basis. We anticipate that in a future upgrade, this information will be obtained from more timely sources, e.g., the Data Assimilation Office (DAO).

CLOUD DETECTION STATUS
Cloud screening is performed prior to the aerosol retrievals. However, the masks currently used do not detect some clouds. The user is cautioned to be aware of this. Most of the detection blunders tend to occur on the edges of well-defined clouds, causing the water or land aerosol retrieval algorithm to be used improperly. These blunders manifest themselves as large values for the aerosol optical depth (> 2). Cloud screening is currently performed with algorithms which use the angle-to-angle differences in radiances across MISR cameras, as well as with the MISR-derived Radiometric Camera-by-camera Cloud Mask (RCCM) and Stereoscopically Derived Cloud Mask (SDCM). Since the quality statement update on November 27, 2002, improvements to the cloud detection scheme have been implemented, which have eliminated the majority of these cloud-edge blunders. Some, however, still remain and work is continuing on the algorithms to further reduce the blunder rate.

AEROSOL OPTICAL DEPTH RETRIEVAL BLUNDERS OVER LAND
Minor populations of retrieval blunders sporadically occur for terrain types having low spatial contrast, most notably bright deserts and snow/ice fields. They are manifested as anomalously large values of optical depth (>2) which appear to be randomly scattered throughout an area. Increased numbers of blunders occur over snow/ice fields as a consequence of inadequate cloud screening. Blunder elimination is a high priority ongoing task.

OPTICAL DEPTH UNCERTAINTIES
Estimates of the uncertainty in the aerosol optical depth over land have been improved by application of more stringent constraints on the heterogeneous land aerosol retrieval algorithm. Previous estimates were too large due to lack of use of spectral information. Uncertainty estimates for aerosols over dark water remain the same as for earlier versions of the algorithm.

ALGORITHM UPDATES
The aerosol retrieval algorithms described in the Algorithm Theoretical Basis document (Revision E, April 2001) have been modified and improved, based on initial analyses of the data. The next release of this document will include an updated description of these algorithms.

EXPERIMENTAL AEROSOL ALGORITHM OVER HOMOGENEOUS SURFACES
A new algorithm which retrieves aerosol properties over homogeneous surfaces is included. However, due to its experimental nature, results from this algorithm are included for diagnostic purposes only. Affected fields in the aerosol product are ChisqHomog, OptDepthHomogCalcPerBand, and ChisqHomogCalcPerBand.

SOME AEROSOL FIELDS NOT AVAILABLE
The following fields in the aerosol product are not currently computed, and should not be used: RegBestFitMixtureEqRefl; RegSfcRetrOptDepthUnc; OptDepthDWCalcPerBand; OptDepthOTACalcPerBand; ChisqAbsCalcPerBand; RelHumidProfile, RelHumidProfileSrc, StratAerFlag, StratAerOptDepth, StratAerOptDepthSrc, CirrFlag, CirrOptDepth, CirrOptDepthSrc.

LAND SURFACE (a.k.a. AS_LAND, MIL2ASLS) (generated by MISR PGE9 executables)

PRODUCT MATURITY
All surface parameters now have "Provisional" status with the exception of BiomeBestEstimateQA,which is not yet implemented.

AEROSOL DEPENDENCY
The land surface product relies on the aerosol product for atmospheric correction information. Therefore, the quality of the land surface product depends upon the quality of the aerosol product, and users are advised to refer to the aerosol product for further information. In the future we anticipate replicating the appropriate aerosol information within the land surface product.

RELIABILITY OF LAND SURFACE REFLECTANCE VALUES DEPENDENT UPON AEROSOL OPTICAL DEPTH MAGNITUDE
At the current time land surface retrievals, particularly those with low surface albedo, should be considered most reliable when the aerosol optical depths are small (< 0.2). For higher albedo areas, such as deserts, good results are obtained for optical depths < 0.4. Thus, it is recommended that users examine the 'RegSfcRetrOptDepth' field in the land surface product as part of their assessments of the surface parameters. This field is the aerosol optical depth at 558 nm (green band), used in the surface retrieval process. Other parameters which indicate the quality of the surface retrieval include 'LandBHRRelUnc' (ratio of BHR uncertainty to BHR value) and 'LandHDRFUncCamAvg' (HDRF uncertainty averaged over the various cameras), which are derived from the uncertainty in the retrieved aerosol optical depth. It can

be assumed that these uncertainty products also apply to the DHR and BRF surface products, respectively. Inspection and analysis of these products, for both dark and bright areas, indicates that they adequately represent the uncertainty associated with their respective products, and therefore are good indicators of product quality. Some sporadic but obvious retrieval blunders do occur, however, for areas that are bright and have little contrast (e.g., deserts and snow/ice fields) and these are easily seen in the images as anomalously bright reflectances. Further refinements in the quality of the aerosol retrievals over land are planned for future releases and these are expected to result in improvements in the surface retrieval blunder rate and product quality at larger optical depths.

QUILTING EFFECT IN LAND SURFACE REFLECTANCES
Most of the retrieved land surface reflectances are reported at a 1.1 km x 1.1 km spacing, whereas the retrieved aerosol optical depths are computed at a coarser 17.6 km x 17.6 km spacing. It is assumed that aerosol amount is constant over any particular 17.6 km region, which results in values of aerosol optical depth that are inherently discontinuous going from one region to an adjacent one. Therefore, the atmospheric correction process, using the coarse resolution aerosol data with the fine resolution reflectance data, occasionally produces a distinctive "quilting" effect in the directional surface reflectance imagery, i.e., a discernable block pattern. Imagery from the extreme off-nadir cameras at 446 nm (blue band) is particularly prone to this effect. The aerosol optical depth discontinuities are due to both real variation in aerosol amount on spatial scales smaller than the 17.6 km spacing and to intrinsic uncertainties associated with the aerosol retrieval process. Because of improvements to the land aerosol retrieval algorithm, the resulting inter-regional optical depth variability, much of which was an artifact of the retrieval process, has now been significantly reduced, thus mitigating, to a large extent, the "quilting" effect. The magnitude of any remaining "quilting" effect is well described by the surface reflectance uncertainty parameters, mentioned in the previous section.

REMOVAL OF BANDING/STRIPING EFFECTS IN LAND SURFACE REFLECTANCES
When the camera view azimuth angles were near perpendicular to the principal plane, the HDRF retrieval algorithm started to break down, producing a more error prone product. As a result, an image of HDRF/BHR or BRF/DHR which included this viewing condition, showed these failing results as bands or stripes within the image. This algorithm defect has been corrected, producing the proper results and eliminating this banding/striping condition.

FILL VALUES IN LAND SURFACE REFLECTANCES
Land surface reflectances are computed separately for each MISR spectral band. In some cases, the land retrievals succeed in one MISR band, but not another. This can cause visualization problems when viewing a composite image of land surface reflectances which contains spectral bands for both successful and unsuccessful retrievals. This occasional algorithm failure in certain bands (notably blue and/or red) is thought to be due to a software error and is a high priority item for investigation and repair.

LAI/FPAR AVAILABILITY AT PROVISIONAL QUALITY LEVEL
The LAI/FPAR fields are now of "Provisional" quality. The software which computes leaf-area index (LAI) and fraction of photosynthetically active radiation (FPAR) uses Land Surface Reflectances (BHR and BRF) as input. Two spectral bands, red and near-infrared, and 7 view directions are currently used to produce LAI and FPAR.

The quality and spatial coverage of LAI and FPAR depend on the quality and coverage of the Land Surface Reflectances (BHR and BRF). Surface reflectances whose uncertainties exceed an acceptable level of 20% result in algorithm failure. The data analysis indicates that uncertainties in the MISR BHR of dense vegetations at red and blue spectral bands can substantially exceed the acceptable level. At these wavelengths, dense vegetations exhibit low reflectances. As indicated in section "RELIABILITY OF LAND SURFACE REFLECTANCE VALUES DEPENDENT UPON AEROSOL OPTICAL DEPTH MAGNITUDE", reliability of land surface retrievals can be low in this case. High uncertainties in BHR retrievals over dark surfaces, therefore, can result in algorithm failure, reducing the number of successful retrievals. With a probability of about 70%, uncertainties in retrieved LAIs do not exceed uncertainties in the MISR Surface Reflectances (BHR and BRF). Inspection and analysis of the LAI/FPAR product indicate that the successfully retrieved LAI/FPAR values follow regularities expected from physics.

Considerable attention was also paid to characterizing the quality of the LAI/FPAR parameters. The quality of LAI/FPAR retrievals can be assessed through examining LAINumGoodFit1 and LAINumGoodFit2 accompanying the product; that is, LAINumGoodFit1*LAINumGoodFit2>0 indicates highest retrieval quality; LAINumGoodFit1>0 and LAINumGoodFit2=0 - intermediate quality. The operational version of the algorithm does not archive low quality retrievals (LAINumGoodFit1=0 and LAINumGoodFit2>0). For more details on the performance of the provisional LAI/FPAR algorithm as well as how to interpret LAIMean1 and LAIMean2 as a function of biome type, the users is referred to Hu et al., Performance of the MISR LAI and FPAR Algorithm: A Case Study in Africa, Remote Sens. Environ (PDF, accepted for publication June 2003).

BHRPAR and DHRPAR AVAILABILITY AT PROVISIONAL QUALITY LEVEL
The BHRPAR and DHRPAR fields are now of "Provisional" quality, as explained in this PDF document.

SOME LAND SURFACE FIELDS NOT AVAILABLE
The following fields in the aerosol product are not currently computed, and contain fill only: BiomeBestEstimateQA.

OCEAN (a.k.a. AS_OCEAN, MIL2ASOS) (from MISR PGE9)

OCEAN NOT YET AVAILABLE
The Ocean Surface product, which contains surface reflectance properties over ocean, has not yet been implemented. It is unavailable at this time.

Also see:

- Statement dated January 25, 2003 for MISR Level 2 Aerosol/Surface Products from January 25, 2003 to August 12, 2003.
- Statement dated November 27, 2002 for MISR Level 2 Aerosol/Surface Products from November 27, 2002 to January 25, 2003.
- Statement dated September 25, 2002 for MISR Level 2 Aerosol/Surface Products from September 25, 2002 to November 26, 2002.
- Statement dated July 29, 2002 for MISR Level 2 Aerosol/Surface Products from July 29, 2002 to September 24, 2002.
- Statement dated April 15, 2002 for MISR Level 2 Aerosol/Surface Products from April 15, 2002 to July 28, 2002.
- Statement dated September 27, 2001 for MISR Level 2 Aerosol/Surface Products from September 27, 2001 to April 14, 2002.
- Statement dated March 30, 2001 for MISR Level 2 Aerosol/Surface Products from March 30, 2001 to September 26, 2001.
- Statement dated February 16, 2001 for MISR Level 2 Aerosol/Surface Products from February 16 to March 29, 2001.